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(56) Documents Cited
GB 2261494 A GB 2216881 A EP 0196621 A2
EP 0132958 A2

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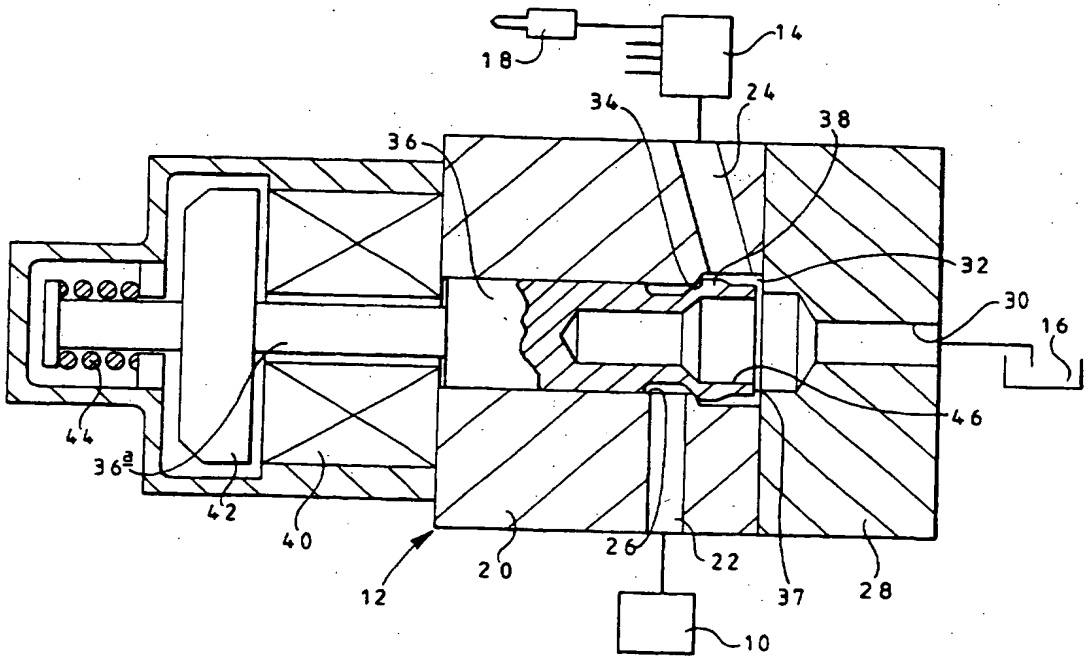
# (54) Valve

(57) A valve comprises a valve member 36 moveable within a body in a first direction. The valve member 36 includes a first, frusto-conical, region engageable with a first, frusto-conical seating 34 to control communication between a first port 22 and a second port 24, and a second region 37 engageable with a surface extending in a plane normal to first direction to control communication between the second port 24 and a third port 30. The valve may be used to control a fuel injection system.

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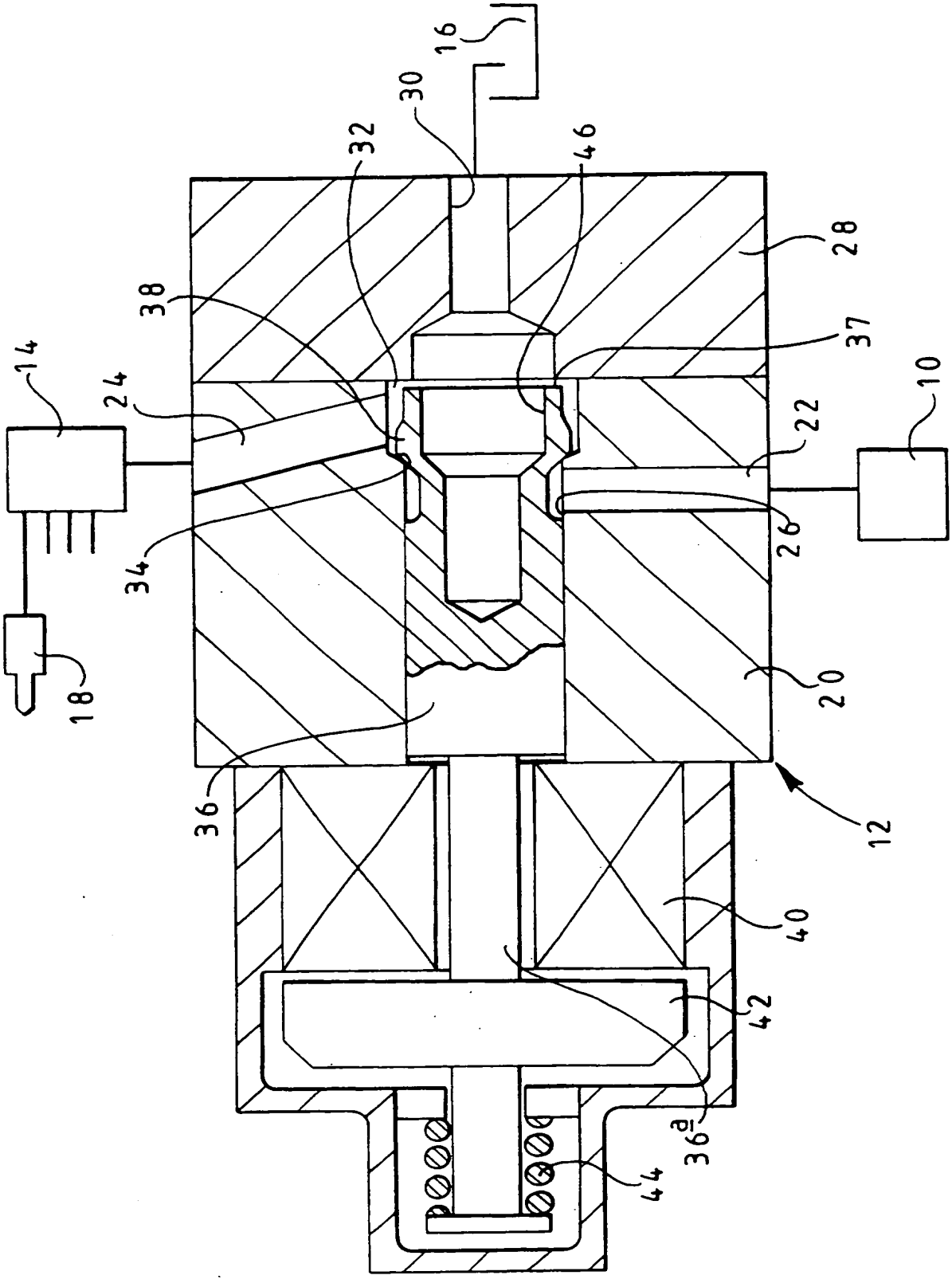
At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995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# VALVE

This invention relates to a valve, and in particular to a valve suitable for use in the fuel supply system of an internal combustion engine.

Where a fuel supply system includes an accumulator arranged to be supplied with fuel by a suitable fuel pump to maintain the fuel pressure within the accumulator within a predetermined range, a three-way valve may be used to control the delivery of fuel from the accumulator to the cylinders of an associated engine, in use. The three-way valve includes an inlet connected to the accumulator, a connection to an injector, or to a distributor arrangement, and a connection to a low pressure spill or drain arrangement. In use, the three-way valve is arranged, in one position, to permit fuel to flow from the accumulator to the injector or distributor arrangement, and in an alternative position to allow fuel flow from the injector or distributor arrangement to the spill or drain arrangement.

It is desirable for the three-way valve to be controlled by a single solenoid actuator, such valves generally including a valve member which is engageable, in its alternative positions, with a pair of concentric seatings. The provision of concentric seatings requires a relatively complex manufacturing process. In an alternative arrangement, a pair of valve members are engageable with respective seatings, the valve members being interconnected by a highly stressed tension rod.

According to the present invention there is provided a valve comprising a valve member slidable in a first direction within a housing, the valve member including a first region sealingly engageable with a first seating

to control fluid flow between a first port and a second port, and a second region which is sealingly engageable with a surface extending in a plane normal to the first direction to control fluid flow between the second port and a third port.

By arranging the second region of the valve member to be engageable with a surface extending in a plane normal to the first direction, the provision of two accurately positioned concentric seatings is no longer required and the use of a highly stressed tension rod can be avoided.

The invention will further be described, by way of example, with reference to the accompanying diagrammatic cross-sectional drawing of a fuel system incorporating a valve in accordance with an embodiment of the invention.

The fuel system illustrated in the accompanying drawing comprises an accumulator 10 which is arranged to be supplied with fuel by a suitable pump to maintain the pressure of fuel within the accumulator 10 within a predetermined range, in use. The accumulator 10 is connected to a three-way valve 12 which is also connected to a distributor arrangement 14 and a spill or drain arrangement 16 of conventional form. The distributor arrangement 14 is arranged to control the distribution of fuel to a plurality of fuel pressure actuable injectors 18 (only one of which is shown) in turn, in use.

The three-way valve 12 comprises a two-part valve body, a first part 20 of which is provided with a first, supply port 22 which communicates with the accumulator 10, and a second, delivery port 24 which communicates with the distributor arrangement 14. The first and second

ports 22, 24 communicate at axially spaced locations with a through bore 26 provided in the first part 20 of the three-way valve body.

A second part 28 of the body of the three-way valve 12 closes one end of the through bore 26, the second part 28 being provided with a third, drain port 30 which extends substantially coaxially with the through bore 26. The third bore 30 communicates with the spill or drain arrangement 16.

The through bore 26 includes a region 32 adjacent the end thereof which is closed by the second part 28 which is of enlarged diameter, the connection between the enlarged diameter part 32 and the remainder of the through bore 26 defining a first seating 34 which is located in a part of the through bore 26 located between the first and second ports 22, 24.

A valve member 36 is slidable within the through bore 26, the valve member 36 being of diameter very slightly smaller than the diameter of the through bore 26 so as to form a substantially fluid tight seal therewith. The valve member 36 includes an enlarged portion 38 located within the enlarged diameter region 32 of the through bore 26, the portion 38 being arranged to be sealingly engageable with the first seating 34 in order to substantially prevent fuel flow between the first and second ports 22, 24. As illustrated in the drawing, the valve member 36 is of reduced diameter adjacent the first port 22 thereby ensuring that high pressure fuel from the accumulator 10 is able to flow to the enlarged diameter portion 32 and second port 24 when the valve member 36 is moved so as to break the engagement between the enlarged portion 38 and first seating 34.

An end 37 of the valve member 36 is engageable with the second part 28 of the body of the three-way valve 12, such engagement preventing fuel flow to the spill or drain arrangement 16. As illustrated in the drawing, the enlarged portion 38 is positioned on the valve member 32 such that when the end 37 engages the second part 28, the enlarged portion 38 is lifted from the first seating 34.

An actuator arrangement is provided to control movement of the valve member 36 within the body of the three-way valve 12. The actuator arrangement comprises a solenoid actuator 40 and an armature 42 which is connected to an extension 36a of the valve member 36, the solenoid actuator 40 and armature 42 being arranged so that energization of the solenoid actuator 40 results in movement of the valve member to break the engagement between the enlarged portion 38 and first seating 34 and to bring the end 37 of the valve member 36 into engagement with the second part 28 of the body of the three-way valve 12. A spring 44 is provided to bias the valve member 36 toward the position shown in which the enlarged portion 38 engages the first seating 34 and the end 37 is lifted from the second part 28 of the body.

In use, in the position shown in the drawing fuel injection is not taking place, the injector 18 being connected through the distributor arrangement 14 and three-way valve 12 with the spill or drain arrangement 16. When it is desired to commence injection, the solenoid actuator 40 is energized to move the valve member 36 against the action of the spring 44 to separate the enlarged portion 38 from the first seating 34 and to bring the end 37 of the valve member 36 into engagement with the second part 28 of the body of the three-way valve 12. Such movement of the valve member 36 permits fuel to flow from the

accumulator 10 through the three-way valve to the distributor arrangement 14 and from there to the injector 18 determined by the distributor arrangement 14. The engagement of the end 37 of the valve member 36 with the second part 28 of the body of the three-way valve 12 forms a seal which prevents fuel flow through the third port 30 to the spill or drain arrangement 16. The outer diameter of the end region of the valve member 36 is substantially equal to the diameter of the through bore 26 thus with the valve member 36 in this position, the valve member 36 is substantially fluid pressure balanced.

In order to terminate injection, the solenoid 40 is de-energized, and as the valve member 36 is substantially pressure balanced, the valve member 36 moves under the influence of the spring 44 to lift the end 37 of the valve member 36 away from the second part 28 of the body of the three-way valve 12. The initial movement of the valve member 36 permits fuel to flow from the enlarged diameter portion 32 of the through bore 26 to the third port 30 and thus increases the pressure acting against the end 37 of the valve member 36, the magnitude of the pressure increase being dependent upon the diameter of the third port 30. Such an increase in the pressure applied to the end 37 of the valve member 36 assists the spring 44 in returning the valve member 36 to the position illustrated in the drawing in which the enlarged portion 38 engages the first seating 34 thus breaking communication between the first and second ports 22, 24, the lifting of the end 37 of the valve member 36 from the second part 28 of the body of the three-way valve 12 permitting fuel flow from the second port 24 to the third port 30 and to the spill or drain arrangement 16. Such a flow of fuel results in the pressure of fuel applied to the injector 18 falling and hence in the injector closing.

As illustrated in the drawing, the valve member 36 is provided with a drilling 46 which reduces the weight of the valve member 36. Such a weight reduction reduces the inertia and thus results in an improvement in the switching time of the three-way valve.

In an alternative arrangement, the drilling 46 may be provided in the end of the valve member 36 remote from the second part 28 of the body, the armature 42 being connected to the valve member 36 by a separate spindle. The end of the valve member 36 presented to the second part 28 would then be substantially planar. In a further alternative, the valve member 36 is hollow, a bore extending completely through the valve member 36. Such an arrangement provides a direct connection between the chamber within which the spring 44 is housed and the drain arrangement 16.

Although the above description relates to a fuel system including a distributor arrangement 14, it will be recognised that the three-way valve 12 could be used in a number of different systems, for example an arrangement in which a separate three-way valve is provided for each injector of an engine to control the operation of that injector, no separate distributor arrangement being necessary in such a system.

## CLAIMS

1. A valve comprising a valve member slidable in a first direction within a housing, the valve member including a first region sealingly engageable with a first seating to control fluid flow between a first port and a second port, and a second region which is sealingly engageable with a surface extending in a plane normal to the first direction to control fluid flow between the second port and a third port.

2. A valve as claimed in Claim 1, wherein the first region and first seating are of frusto-conical shape.

3. A valve as claimed in Claim 1 or Claim 2, further comprising a spring biasing the valve member towards a position in which the first region engages the first seating and the second region is spaced from the said surface.

4. A valve substantially as hereinbefore described with reference to the accompanying drawing.

The Patent Office

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**Application No:** GB 9606492.8
**Claims searched:** 1-4

**Examiner:** Steve Waller
**Date of search:** 7 May 1997

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2V VR3, VP182

Int Cl (Ed.6): F16K 11/04, 11/044

Other:

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| X | GB 2.216,991 A | (SPENCER WRIGHT) See valve member 28, figure 1 | 1,2 |
| X | GB 2,261,494 A | (BOSCH) See page 4 lines 10 to 21 | 1,3 |
| X | EP 0,196,621 A2 | (HONEYWELL) See figure 2 | 1,3 |
| X | EP 0,132,958 A2 | (ACUMETER) See figure and valve member 12 | 1,2 |

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| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |